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Gaming Summary Report

Introduction

The following is a summary of the Gaming results. Gaming was conducted by the WMCT during the weeks of 11/15 and 11/22. Games simulated the potential effects of the Water Quality Control Plan and CVPIA b(2) actions on system hydrology and water supply. Limited EWA assets were included in the games.

Games undertaken were designated 1A and 1B. Game 1A represented early Stage 1 conditions and assets. Game 1B represented late Stage 1.

Participants included representatives of CALFED, the USFWS, CDFG, NMFS, USBR, CDWR, water districts, and environmental organizations.

Methods

Simulating Water Management System Operations

Gaming simulation involved real-time modeling of system operations using historic daily and monthly hydrology and operations data as input. New operation rules, system storage regulations (e.g., USACE flood control rules), WQCP standards, and export and delivery demands of water users are simulated along with new assets and fish protection actions. Model simulations predict the effect of new assets on water supply and system operations. Flow and export changes suggested by fish agencies are simulated and effects on system operations, water supply, and system hydrology observed. Simulations generally consisted of making changes to a baseline condition and then observing differences in model parameters generated by any changes made. Model simulations have a turnaround of only several minutes, thus providing quick feedback to gaming participants and also to allow participants to make adjustments to actions and level of actions.

Simulation Models

DWR's DWRSIM model and the DAILY OPS model developed by Russ Brown from Jones and Stokes Inc. were used to simulate system hydrology, project operations, and EWA actions. The DAILY OPS model is a Lotus spreadsheet model with extensive interactive and charting capabilities. System operations input and output data from DWR's DWRSIM monthly system operations model were inputs into the DAILY OPS model. System operations changes including EWA actions were fed into the DAILY OPS model to observe changes in daily hydrology and systems operations, and effects of EWA and other actions. Changes in hydrology and system operations were then fed back into DWRSIM and the simulation thus progressed year-to-year using the two models. Years 1981-1990 were simulated as a sequence in the order they occurred.

Fish Templates

Fish templates were designed to guide asset allocation during the simulations and are based on the perceived needs of key fish species in terms of flows and export restrictions developed from the historical operation and hydrology conditions simulated in the models. Fish templates were developed for each year of the model simulation from historical fish salvage and project operation data. Each need or concern identified was given a priority based on perceived risk to the respective fish populations, which included *the state of the population in the year in question.*

Application of Fish Protection Actions

Fish protection actions were applied during simulations based on the fish templates and systems operations information as the simulation played out. Fish protective actions included upstream storage releases and in-Delta export reductions. Assets were allocated as needed to carry out the fish protection actions and to pay off debts to water supplies as necessary.

Simulation of New System Assets

Asset	Early Stage 1	Late Stage 1
Expanded Banks	Existing rules plus 500 cfs more allowed in summer period per 1999 actions.	Full use of 10,300 cfs capacity was allowed per meeting other rules.
JPOD	Allowed.	Allowed.
Intertie	Included.	Included.
Groundwater Banking	100 TAF of purchase available in all years except third year or more of drought.	100 TAF of purchase available in all years except third year or more of drought.
Delta Island Storage	Not included.	200 TAF of capacity included with one-half directly connected to south Delta pumping plants.
Delta Barriers	Not included.	Included.
Hood-Mokelumne Connector	Not included.	Not included.
New Fish Facilities at Clifton Court Forebay (CCF) and Tracy	Not included.	Included.
CVPIA b(2) Water	Included upstream AFRP actions, WQCP, in-Delta actions. No b(2) water banking.	Included upstream AFRP actions, WQCP, in-Delta actions. No b(2) water banking.
ERP Water	Not included.	Not included.
Enlarged Shasta	Not included.	Assumed an additional 290 TAF of storage capacity.
EWA Assets	Relaxation of E/I standard.	Relaxation of E/I standard.

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Results

Fish Actions Employed

Fish Template Feature	Early Stage 1 (Game 1A)	Late Stage 1 (Game 1B)
1981		30-day VAMP
1982		One week export restriction in Dec. 60-day VAMP (export limits 3000-5000 cfs). One week export restriction in June to 10,000cfs.
1983		With high inflow, restricted exports to 7000 cfs in November, 5000 cfs Dec-mid Apr. 3000 cfs VAMP limit mid-Apr to mid-May. 7500 cfs export limit mid-May through June.
1984		Restricted exports to 5000 cfs in Mar. 2250 cfs VAMP export limit mid-Apr to mid-May. 3000 cfs export limit first half of Apr and last half of May.
1985		30-day VAMP
1986		Dec export restriction to 8,000 cfs. Two-week export restriction in Feb to 7500 cfs. 30-day VAMP
1987		March restriction to 5,000 for two weeks. 30-day VAMP.
1988		December and early January export restriction to 7500 cfs. 75-day VAMP from mid-Mar through May. Restrict exports in first half of June to 3000 cfs.
1989		Late December and early January 4-week export restriction to 5,000 cfs. March and early April export 4-week restriction to 10,000 cfs. 2250 cfs 30-day VAMP.
1990		Export restriction in January to 13,000 cfs. 30-day VAMP. Export restriction to 3000 latter half of May, all of June, and first week of July.

Water Supply Actions Employed

Asset Used	Early Stage 1 (Game 1A)	Late Stage 1 (Game 1B)
1981		Exported from Delta island storage; limited use of Expanded Banks in July (not needed in winter).
1982		Two months in winter and two months in summer full Expanded Banks; Exported from Delta island storage.
1983		One month in fall, two months in summer of Expanded Banks.
1984		Limited use of Expanded Banks in summer, otherwise not needed. Exported from Delta island storage.
1985		Exported from Delta island storage. Filled Delta island storage and used Expanded Banks fully from mid-Nov to mid-Dec. Expanded Banks used through January and part of February, and then again in Jul-Aug.
1986		Expanded Banks used through January and part of February, and then again in March.
1987		Expanded Banks used in part of Oct, Jan, and then again in July.
1988		Expanded Banks used in Jan, otherwise insufficient inflow available.
1989		Expanded Banks used in July to make up storage in San Luis Reservoir.
1990		Expanded Banks used in part of Jan.

B(2) Accounting

	Game 1A - Early Stage 1				Game 1B - Late Stage 1			
Year	Upstream Cost	WQCP Cost	Other Delta Costs	Storage Change (WS cost)	Upstream Cost	WQCP Cost	Other Delta Costs	Storage Change (WS cost)
1981	150	430	220	(400)[1]	350	320	130	(400)[2]
1982	0	50	750	(630)	0	50	750	?
1983	0	0	800	0	0	0	700	0
1984	0	225	575	(590)	0	50	820	(450)
1985	275	390	135	(800)	240	440	120	(450)
1986	0	165	610	(370)	0	165	470	(340)
1987	160	445	200	(235)	250	450	130	(255)
1988	60	450	290	(40)[1]	45	410	345	40[2]
1989	35	415	350	(400)	60	415	325	(400)
1990	20	450	330	(180)[1]	30	450	320	(30)[1]

[1] Also a 10% reduction in deliveries from San Luis Reservoir.
[2] Also a 5% reduction in deliveries from San Luis Reservoir.

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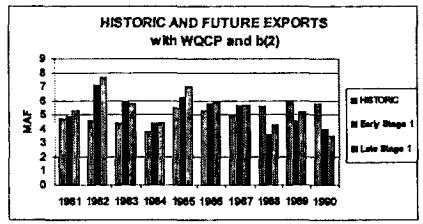
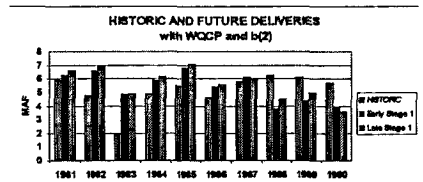
Exports

Model simulations for the period 1981-1990 under 1995 demand level with new assets and constrained by the WQCP and b(2) actions predict future exports will increase in wet years (1982, 1983, 1984, and 1986) and dry years following wet years (1981, 1985, and 1987), and decline in dry years following dry years (1988-1990). B(2) actions and WQCP constraints limit exports in extended droughts. In wet years in late Stage 1 an Expanded Banks will allow greater exports from the Delta. In extended droughts new assets in late Stage 1 will help to reduce export reductions at least in early years (e.g., 1988-1989), but may lead to greater reductions in exports in the fourth (e.g., 1990) or later years of an extended drought. Additional actions applied under the EWA may limit exports beyond that predicted under the WQCP and CVPIA b(2) implementation.



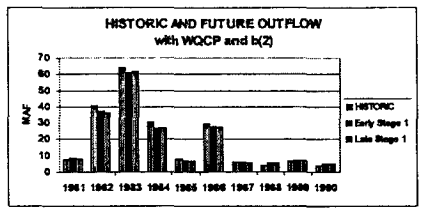
Deliveries

Model simulations for the period 1981-1990 predict deliveries will increase in wet years (1982, 1983, 1984, and 1986) and dry years following wet years (1981, 1985, and 1987), and decline in dry years following dry year (1988-1990), similar to the export pattern. When water supplies are limited, protections under the WQCP and b(2) actions will reduce export and thus deliveries when compared to historic conditions under D-1485 water quality standards.



Delta Outflow

Model simulations for the period 1981-1990 predict outflow will decrease slightly in wet years (1982, 1983, 1984, and 1986) and some dry years following wet years (1985 and 1987), and increase measurably in dry years following dry years (1988-1990). When water supplies are limited (dry years following dry years), protections under the WQCP and b(2) actions will reduce export and deliveries, and thus allow more inflow to reach the Bay compared to conditions under historic D-1485 water quality standards. Though such reductions are small on an annual basis, they are often confined to important spring periods when impacts to fish are more important.



Discussion

Synergies of Assets

Model simulations and the gaming associated with the simulations identified synergies in managing the EWA, ERP, and CVPIA b(1), b(2), and b(3) water accounts. With different allocations, implementation rules, and target actions, the accounts were more efficient when assets and responsibilities were combined. For example, there were times when a CVPIA objective was more effectively achieved using EWA assets rather than b(2) assets and rules. It was also apparent in the gaming process that the CVPIA b(1) and b(3) provisions were very similar in concept to the EWA.

In addition to synergies among the environmental objectives, simulations also indicated opportunities for synergies among the environmental, water quality, and water supply assets. For example, opportunities were identified where EWA water held in San Luis helped to maintain the storage level above the summer low-point that limits deliveries from the projects. EWA water could also be borrowed or purchased to meet water supply deliveries. EWA actions to reduce exports or increase flows often indirectly benefited water quality of urban water exported from the Delta. Gaming included actions taken by the EWA and urban water users to share the cost of increasing Delta outflow to lower salt content and keep fish away from project pumping plants.

Simulations also identified obvious synergies and supply benefits of the SWP and CVP operating under a Joint Point of Diversion (JPOD) process. Though JPOD is considered a new water supply asset, the existing Coordinating Operating Agreement (COA) and State Board regulations governing the two projects allow for sharing and efficiencies when exporting to their respective facilities and in sharing San Luis Reservoir storage. Gaming also identified other opportunities to share upstream storage and conveyance facilities that would provide environmental benefits as well as water supply benefits.

Simulating CVPIA b(2)

Simulations included b(2) water, actions, and accounting rules as key components of an EWA. Because no specific guidance was available for use of the b(2) account, simulations incorporated AFRP upstream actions and export restrictions in the Delta as recommended by Interior[1] above those prescribed by the WQCP. Future b(2) actions will be "*based on biological needs, hydrologic circumstances, and water availability. The FWS will select appropriate actions for any given year following consultation with the Bureau of Reclamation and the California Department of Water Resources and in cooperation with the California Department of Fish and Game and stakeholders.*"[1]

Upstream Actions - Fall/Winter Period (October-January)

In the b(2) model simulations, water was generally released from upstream storage only to meet prescribed AFRP May 1997 Plan target flows below upstream reservoirs in the Sacramento, American, and Stanislaus rivers as recommended by Interior[1]. Water released from CVP storage in the October-January period for environmental purposes relating to CVPIA objectives was generally classified as b(2) water. However, there were instances when storage releases could have been classified as b(1) water if an argument could be made that the releases could be made as a consequence of project re-operation. However, because it was difficult to determine what type of actions would qualify as a b(1) action under the language of the Act, releases were generally attributed to the b(2) account. If reservoirs refilled by the end of January, then no charge to the b(2) account was made for the October-January releases per the Proposed Interior Decision.

Water released for upstream actions was also available for recapture and reuse, including export. Gaming identified opportunities to increase storage releases at one reservoir and reduce releases at another, essentially equating the actions as a water transfer from the one reservoir to the other. Water released upstream could also be exported to Delta Island storage or export to San Luis Reservoir if storage and conveyance capacity were available. Simulations generally allowed upstream b(2) water to be captured by the projects, but not for the EWA or b(2) account. Although Interior[1] allows water to be banked and held as an EWA or b(2) asset, gaming did not include these options, because rules for such actions were not provided by the Proposed Interior Decision.

[1] Attachment 2 of *Proposed Decision on Implementation of Section 3406 (b)(2) of the Central Valley Project Improvement Act – July 15, 1999.*

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Upstream Actions - February through September

Water released from CVP reservoirs specifically for fishery actions in the February through September period is charged to the b(2) account. This water is accounted for on a daily basis. Net changes in releases are used for b(2) calculations. The FWS, upon written assessment of benefits to fishery, may allow water to flow through the Delta (outflow to the Bay). Pass-through water would be charged to upstream actions and not be accounted for against Delta actions. Such actions were rarely used in gaming simulations because upstream releases were generally higher than prescribed AFRP flows. Upstream releases could have been used for benefits to the Delta, but were not considered.

Water Quality Control Plan

Model simulation costs attributed to Delta actions of the WQCP were split between the SWP and CVP, and up to the first 450 TAF of the CVP cost was charged to the b(2) account per the Interior Rules. Generally such costs were to maintain X2 and export/inflow criteria of the WQCP, but some WQCP costs to maintain water quality were also charged to the b(2) account.

Delta Actions - Year-Round

Export reductions under b(2) to protect fish were also charged to the b(2) account. Such actions were taken only if assets were available after upstream and WQCP debits were allocated. Generally with the 450 TAF limit from the WQCP, some of the 800 TAF allocation of b(2) water was left for reducing exports. Rules limiting February through August export reductions to 640 TAF, or lower (by 25%) in times of water shortage were generally ignored when simulating b(2). Actions included those recommended by Interior:

- *Curtail total Delta CVP/SWP export during critical out-migration periods.*
- *Ramp exports up gradually after export curtailment.*

Two additional actions recommended by the FWS were generally heeded but not addressed directly because there was no specific direction:

- *Maintain positive QWEST flows – AFRP In-Delta Action #8 specified maintaining a positive QWEST in December and January.*
- *Increase end-of-September storage in CVP reservoirs*

Expanded Banks Pumping Capacity

Gaming simulations indicate that use of the Expanded Banks pumping capacity could substantially improve water supply and water supply reliability during and after EWA export restrictions. Higher exports particularly in winters of wetter years increased potential export, deliveries, and carryover storage in San Luis Reservoir. Higher export capacity after the spring VAMP export restriction (often April through June) allowed faster makeup of San Luis storage depleted during the export restrictions. The makeup was usually allowable from increased storage releases if sufficient supplies were available in upstream reservoirs. Such releases were often at a cost to water supply if the reservoirs did not refill the subsequent winter. Opportunities were sometimes available to backup water into upstream reservoirs during spring export restrictions, thus limiting the cost to water supply.

In-Delta Storage

In-Delta storage can improve water supply yield up to the capacity of the storage in some years. In simulations 200 TAF was used as the limit per specifications of the Delta Wetlands Project. The asset may not be used in wet years because of lack of need. In drier years there were limited opportunities to fill the storage. In intermediate years there were times when such storage could be filled and used more than once, thus providing water supply benefit beyond 200 TAF.

Enlarged Shasta Project

A 290 TAF enlarged Shasta project was simulated as a late Stage 1 asset. In wet years with substantial inflow the expanded capacity allowed a higher initial storage level and a substantial capability to extend releases and provide additional carryover storage. More water could be carried into the winter flood control season with less winter spilling. In prolonged drought periods, the expanded capacity benefited water supply only in the initial carryover storage.

Groundwater Banking

Storage and release capabilities from groundwater banks helped to maintain project deliveries during and after the spring export restriction period. Groundwater storage was refilled when excess water and export capacity were available the following fall and winter. Groundwater banking proved more efficient with the Expanded Banks pumping capacity. Groundwater banking was limited by in-and-out capacities.

Joint Point of Diversion

The JPOD was essential in maximizing the efficiency of the system particularly in allowing use of SWP pumps to refill CVP San Luis storage. Simulations tracked water supply separately, but the simulations showed that JPOD maximized overall water supply benefits.

Demand Shifting

Demand shifting was simulated simply as a shift in demand from prior to the San Luis low-point of late summer or fall to the post low-point period. The simulations assumed 60 TAF of demand could be shifted by MWD south of the Delta to allow more spring VAMP-type constraints on exports without impacts to south of Delta project deliveries.

Water Purchases and Transfers

Simulations generally did not include water purchases or transfers, or their potential benefits to water supply and water supply reliability, or the environment.

Simulation of Other b(2) elements.

Operations

The FWS proposed targeting a maximum of 200-350 TAF of actions for fall/winter at the beginning of the periods. These would be adjustable with changes in monthly forecasts over the period. The simulation generally allocated up to the 350 TAF limit if AFRP flow prescriptions required that amount.

Banking

A portion of the b(2) water allocation can be banked in CVP or non-CVP facilities for fish and wildlife purposes. Banked water could not be included in the accounting for Upstream Actions. Costs for such banking and use of banked water are to be born by FWS. Banking was generally not included in gaming simulations because of the difficulty in defining rules for banking and use of banked water.

Transfers/Exchanges

Transfer of upstream CVP reservoir water to other water users for fish and wildlife purposes is allowed under CVPIA b(2), but was rarely employed in simulations because of restrictions and vague rules for development and use.

Relationship with SWP

Interior's Proposed Rules stated that obligations under WQCP and ESA actions might reduce CVP's ability to support the SWP. However, simulations generally indicated the SWP substantially benefited from b(2) actions and associated constraints on the CVP.

Potential Synergies between EWA and CVPIA b(2) Programs.

Gaming and simulations generally indicated many opportunities for synergies between an EWA and the b(2) program. All such synergies would require approval and evaluation before being allowed under the

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b(2) program. The EWA Coordinating Team developed a list of questions for Policy makers to address before such synergies would be considered in an EWA program.

B(2) Accounting

Accounting for the b(2) water allocations and accurate debiting of the b(2) account proved difficult under guidance provided by Interior[1].

- Though CVPIA Section 3406(b)(2)(C) provides for up to a 25 % reduction in b(2) water when agricultural deliveries are reduced because of hydrological circumstances (e.g. drought), simulations did not cut back on the b(2) allocation because no criteria were given for how big the cutbacks should be or under what specific circumstances the cutbacks would be applied.
- Because water released for upstream actions October-January could be exported by the projects, b(2) curtailment of such exports was essentially double billed to the b(2) account per Interior's Proposed Rules[1].

Simulating the ERP Water Assets

No attempt was made to simulate ERP water assets. Assets described in the ERP Report could effectively be included in the EWA, acknowledging that ERP objectives would first have to be met, and then the EWA could use the water thereafter. Questions arose to the availability of ERP water in Stage 1.

Constraints on EWA Use

Use of EWA water in simulations was constrained similarly to other water action in the Central Valley. No allowances were made to relax requirements for the EWA. Additional potential benefits were often identified if the EWA were not constrained by all such requirements. The potential benefits of an EWA action were identified that would far outweigh potential impacts of the action. Such tradeoffs could substantially improve the potential benefits of the EWA.

Appendices

Fish Templates for 1981-1990

Game 1A Charts – Early Stage 1 Hydrology

Game 1B Charts – Late Stage 1 Hydrology

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